

**Division of Environmental Health  
Maine Center for Disease Control and Prevention  
Department of Health & Human Services**

**Environmental & Occupational  
Health Program**

**Interdepartmental Memo**

To: Naji Aklaidis, DEP

From: Pamela Wadman, MeCDC

cc: Andrew E. Smith, ScD, MeCDC, David Wright DEP

Date: June 6, 2014

Re: Human Health Risk-Based Screening Levels for Perfluoroalkyl Compounds

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As requested by DEP, MeCDC has derived human health risk-based screening levels for the perfluoroalkyl compounds (PFCs): perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Screening levels (SLs) were developed for exposures to soil, sediment, groundwater, surface water, and for the ingestion of fish.

Health risk-based SLs for these PFCs are based on non-cancer effects because cancer toxicity values have not been established. At this time, there are no federal chronic non-cancer toxicity values for PFOA and PFOS, however several states including Maine have derived chronic toxicity values, and EPA is in the process of developing values (Federal Register 2014). For PFOA, MeCDC has derived a chronic oral toxicity reference dose (RfD) of  $6 \times 10^{-6}$  milligram/kilogram-day (mg/kg-day), as presented in the Maine Maximum Exposure Guideline for Perfluorooctanoic Acid in Drinking Water (MeCDC 2014). For PFOS, the SLs use the sub-chronic RfD of  $8 \times 10^{-5}$  mg/kg-day derived by the EPA Office of Solid Waste and Emergency Response (EPA 2009).

SLs were derived using “Guidance for Human Health Risk Assessments for Hazardous Substance Sites in Maine” (DEP 2011). Additional technical support documents, including Maine-specific exposure factors, are described for each media below. Where applicable, SLs include ingestion, dermal and inhalation pathways. Inhalation SLs were not calculated for the PFCs due to the lack of inhalation toxicity information.

Potential receptors for exposure to PFCs in soil include the resident, the recreational user, and commercial and construction workers. Surface water and sediment present a potential exposure pathway for the recreational user (wading or swimming) and the construction worker. SLs for residential groundwater exposure are the Maine Maximum Exposure Guidelines for Drinking Water, which are based on ingestion, with incorporation of an allowance for other potential exposure pathways. Groundwater exposure for the construction worker includes both ingestion and dermal exposures. The media specific SLs for both soil and sediment, and both ground water and surface water for the construction worker are equivalent due to the use of consistent exposure assumptions for these media.

## 1. Soil

The methodology used for the derivation of soil and sediment SLs is presented in “Technical Basis and Background for the 2013 Maine Screening Levels for Soil Contaminated with Hazardous Substances” (DEP 2013). The soil and sediment SL calculations were validated using the Regional Screening Levels for Chemical Contaminants at Superfund Sites (EPA 2014), modified with Standard Default Exposure Assumptions for Maine Risk Assessments (DEP 2013b). Soil SLs are presented in Table 1. The soil SL calculations with equations and exposure parameters are presented in Appendix 1.

**Table 1. Soil Screening Levels for Perfluorinated Compounds (mg/kg)**

	<b>Resident</b>	<b>Park User</b>	<b>Outdoor Commercial Worker</b>	<b>Excavation or Construction Worker</b>
<b>PFOA</b>	0.80	1.3	6.2	1.4
<b>PFOS</b>	11	18	82	19

## 2. Sediment

Sediment SLs incorporate the ingestion and dermal contact pathways for adult and child recreational exposure scenarios, as described in the “Technical Basis and Background for the 2013 Maine Screening Levels for Soil Contaminated with Hazardous Substances”(DEP 2013). Sediment SLs are presented in Table 2. The sediment SL calculations, equations and exposure parameters are presented in Appendix 2.

**Table 2. Sediment Screening Levels for Perfluorinated Compounds (mg/kg)**

	Recreational Child Wading	Recreational Adult Wading	<b>Recreational Sediment Screening Level<sup>1</sup></b>
<b>PFOA</b>	1.5	14	1.5
<b>PFOS</b>	20	187	20

<sup>1</sup>. The recreational sediment screening level is the lowest of the adult and child screening levels.

### 3. Groundwater

SLs for groundwater exposure were developed for the resident and the potential future construction worker. For the residential groundwater exposure pathway, SLs were derived in accordance with Maine CDC procedures for development of Maximum Exposure Guidelines (MeCDC 2011). The methodology for derivation of construction worker groundwater SLs is presented in Wilcox and Barton, Inc., “Development of Construction Worker Groundwater Screening Levels (RAGs), June 21, 2012 (Wilcox and Barton 2012). In deviation from the Wilcox and Barton methodology, the groundwater exposure time was changed from 20 minutes per day to 8 hours per day, in agreement with the construction worker surface water exposure time presented in the Standard Default Exposure Assumptions for Maine Risk Assessments (DEP 2013b). Groundwater SLs are presented in Table 3. The groundwater SL calculations with equations and exposure parameters are presented in Appendix 3.

**Table 3. Groundwater Screening Levels for Perfluorinated Compounds (ug/L)**

	<b>Resident</b>	<b>Construction Worker</b>
<b>PFOA</b>	0.13	0.22
<b>PFOS</b>	0.56	5.3

ug/L = microgram per liter

#### 4. Surface Water

Surface water SLs were derived for ingestion and dermal contact, for both adult and child recreational wading and swimming exposure scenarios, as presented in the Guidance for Human Health Risk Assessments for Hazardous Substance Sites in Maine (DEP 2011). The dermal-water pathway was included in the surface water exposure scenario as recommended in the EPA Risk Assessment Guidance (RAGs) for Superfund Volume 1 (Part E, Supplemental Guidance for Dermal Risk Assessment) (EPA 2004). The dermal water pathway for PFC compounds is complicated because the compounds' surfactant properties make estimation of the octanol-water partition coefficient ( $K_{ow}$ ) difficult (Arp et al. 2006). EPA has stated that  $K_{ow}$  values for PFOA and PFOS are not measurable (EPA 2013). Due to known inconsistencies in experimentally measured  $K_{ow}$  values for PFCs, it is appropriate to utilize  $K_{ow}$  values estimated based upon chemical structure. Consistent with EPA practice,  $K_{ow}$  values for PFOA and PFOS were estimated using the Estimation Program Interface (EPI) Suite, as cited in ARP and Goss (2006). The RAGS Part E dermal guidance includes a discussion of uncertainty that is introduced when an estimated octanol-water partition coefficient ( $K_{ow}$ ) is outside of the Effective Prediction Domain (EPD) for estimation of the dermal permeability coefficient using the Potts and Guy equation. However, without an alternative, the EPA recommendation is to include the dermal water exposure pathway for compounds with  $K_{ow}$  values outside the EPD (EPA 2004, page A-4). If the surface water SL's thus calculated trigger inclusion of PFCs in a risk assessment, the dermal water pathway may be discussed in the uncertainty section (EPA 2004, page 6-2). Surface water SLs are presented in Table 4. The surface water SL calculations with equations and exposure parameters are presented in Appendix 4.

**Table 4. Surface Water Screening Levels for Perfluorinated Compounds (ug/L)**

	Child Wading	Child Swimming	Adult Wading	Adult Swimming	Recreational Surface Water Screening Level <sup>1</sup>	Construction Worker Screening Level <sup>2</sup>
<b>PFOA</b>	0.060	0.050	0.44	0.27	0.05	0.22
<b>PFOS</b>	1.4	1.2	10.4	6.5	1.2	5.3

ug/L = microgram per liter

<sup>1</sup>. Recreational surface water screening level is the lowest of the adult and child screening levels.

<sup>2</sup>. The construction worker surface water exposure is the same as a groundwater exposure.

## 5. Fish Tissue

Fish tissue SLs were developed using the approach presented in the Maine CDC document “Bureau of Health Fish Tissue Action Levels”(MeCDC 2001). Screening levels were developed using the upper level fish ingestion rate for Maine recreational anglers, 32.4 grams/day (one eight ounce meal per week). In addition, SLs were developed using the federal Superfund ingestion rate of 54 grams/day for consumption of locally caught fish, and 132 grams/day for subsistence fishermen (EPA 2009). Fish tissue SLs are presented in Table 5. The fish tissue SL calculations with equations and exposure parameters are presented in Appendix 5.

**Table 5. Fish Tissue Screening Levels (ug/kg)**

<b>Consumer</b>	<b>Maine Recreational Angler</b>	<b>EPA Recreational Fisher</b>	<b>Subsistence Fisher</b>
Ingestion rate reference	Maine CDC	EPA 1991	EPA 1991
Fish meals per week	1	2	4
Ingestion rate - grams/day	32	54	132
<b>PFOA</b>	13	7.8	3.2
<b>PFOS</b>	175	104	42

ug/kg = microgram per kilogram

## References

- Arp and Goss 2006. Arp, H., Niederer, C., and Goss, K.: Predicting the Partitioning Behavior of Various Highly Fluorinated Compounds, *Environ. Sci. Technol.*, 40, 7298–7304, 2006.
- DEP 2011. Guidance For Human Health Risk Assessments for Hazardous Substance Sites in Maine February 2011. [http://www.maine.gov/dep/spills/publications/guidance/rags/final\\_5-8-2013/1%20Risk%20Manual-Feb\\_2011-%20CC.pdf](http://www.maine.gov/dep/spills/publications/guidance/rags/final_5-8-2013/1%20Risk%20Manual-Feb_2011-%20CC.pdf)
- DEP 2013. Technical Basis and Background for the 2013 Maine Screening Levels for Soil Contaminated with Hazardous Substances. Available at: <http://www.maine.gov/dep/ftp/RAGS-Background-Documents/>
- DEP 2013b Standard Default Exposure Assumptions for Maine Risk Assessments. Available at <http://www.maine.gov/dep/spills/publications/guidance/index.html>
- EPA 1991 Risk Assessment Guidance For Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance "Standard Default Exposure Factors" (1991) available at: [http://www.epa.gov/oswer/riskassessment/pdf/oswer\\_directive\\_9285\\_6-03.pdf](http://www.epa.gov/oswer/riskassessment/pdf/oswer_directive_9285_6-03.pdf)
- EPA 2004. Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual Part E, Supplemental Guidance for Dermal Risk Assessment Available at <http://www.epa.gov/oswer/riskassessment/rage/index.htm>
- EPA 2009. Memorandum The Toxicity of Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) October 28, 2009 available at: <http://www.epa.gov/opptintr/pfoa/pubs/Final%20PFOA%20PFOS%20RfD%20memo%2010-28-09.pdf>
- EPA 2013 Emerging Contaminants – Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) March 2013  
Available at: [http://www2.epa.gov/sites/production/files/documents/ec\\_technical\\_fs\\_pfos\\_pfoa\\_march\\_2013.pdf](http://www2.epa.gov/sites/production/files/documents/ec_technical_fs_pfos_pfoa_march_2013.pdf)
- EPA 2014. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Available at: [http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl\\_search](http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search)
- Federal Register 2014. "Request for Nominations for Peer Reviewers and Notice of Public Comment Period for Draft Health Effects Documents for Perfluorooctanoic Acid and Perfluorooctane Sulfonate" Federal Register Vol. 79, No. 40 (28 February 2014 pp.11429-11430. Available at: <http://www.gpo.gov/fdsys/pkg/FR-2014-02-28/pdf/2014-04455.pdf>
- MeCDC 2001. Bureau of Health Fish Tissue Action Levels, 2/20/01. Available at: <http://www.maine.gov/dhhs/mecdc/environmental-health/eohp/fish/documents/action-levels-writeup.pdf>
- MeCDC 2011. Maine Center for Disease Control and Prevention Maximum Exposure Guidelines for Drinking Water February 2011. Available at: <http://www.maine.gov/dhhs/mecdc/environmental-health/eohp/wells/documents/megprocedures2011.pdf>
- MeCDC 2014. Maine Maximum Exposure Guideline for Perfluorooctanoic Acid in Drinking Water Available at: <http://www.maine.gov/dhhs/mecdc/environmental-health/eohp/wells/documents/pfoameg.pdf>
- Wilcox and Barton 2012. Development of Construction Worker Groundwater Screening Levels (RAGs), June 21, 2012. Available at: <http://www.maine.gov/dep/ftp/RAGS-Background-Documents>